May 30, 1967 C. W. MANN 3,321,833

MANUFACTURE OF SHOES

Filed Nov. 7, 1963 3 Sheets-Sheet 1

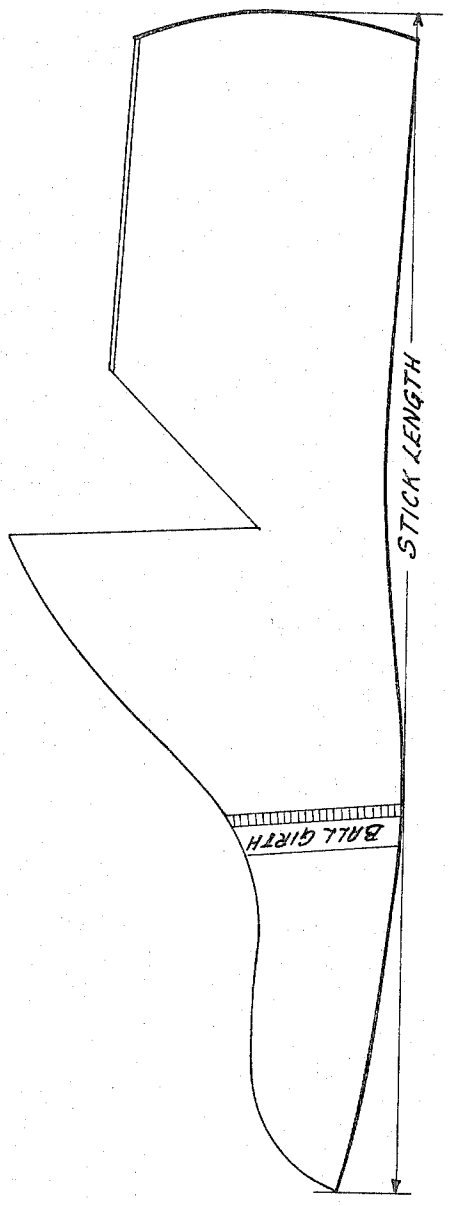

FIG. 1

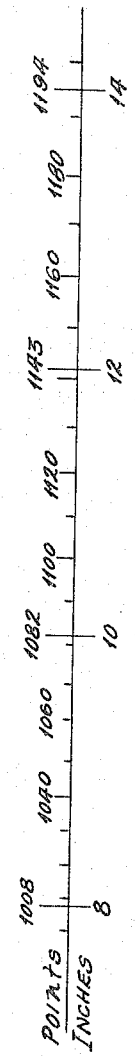

FIG. 2

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MANUFACTURE OF SHOES

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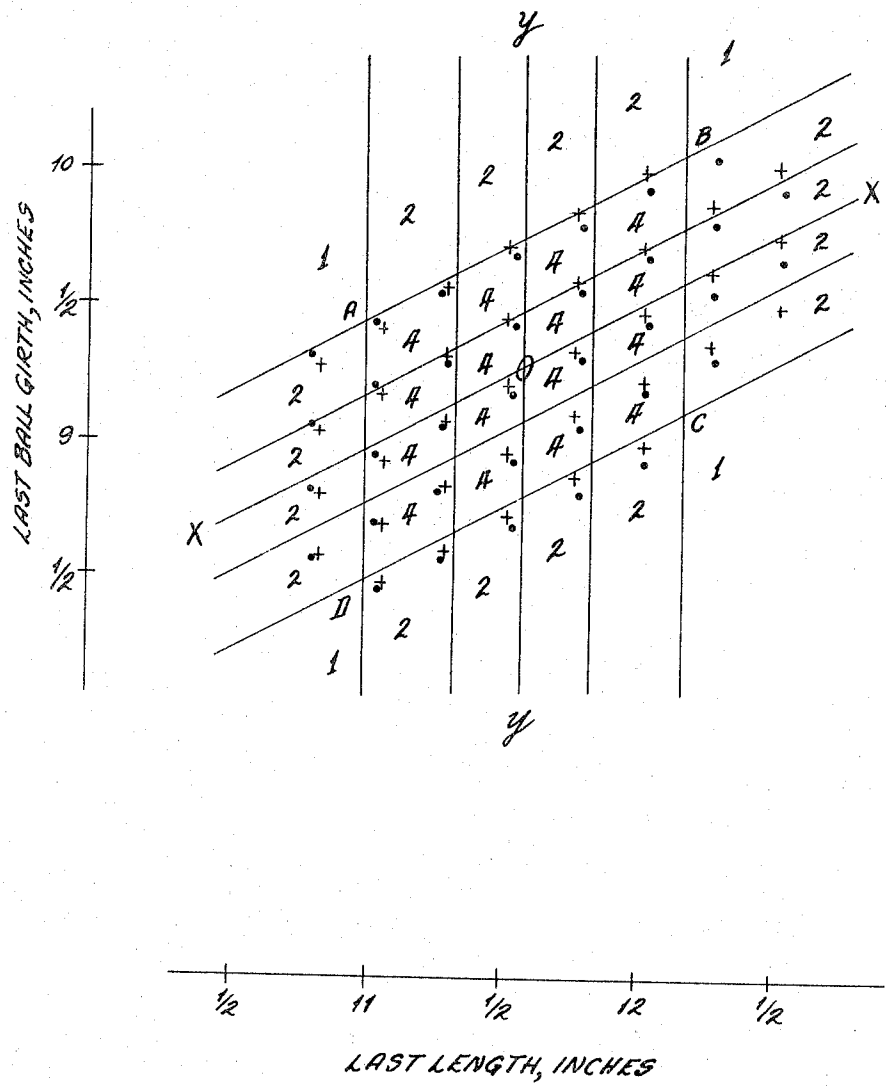

FIG. 3

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MANUFACTURE OF SHOES

Filed Nov. 7, 1963 3 Sheets-Sheet 3

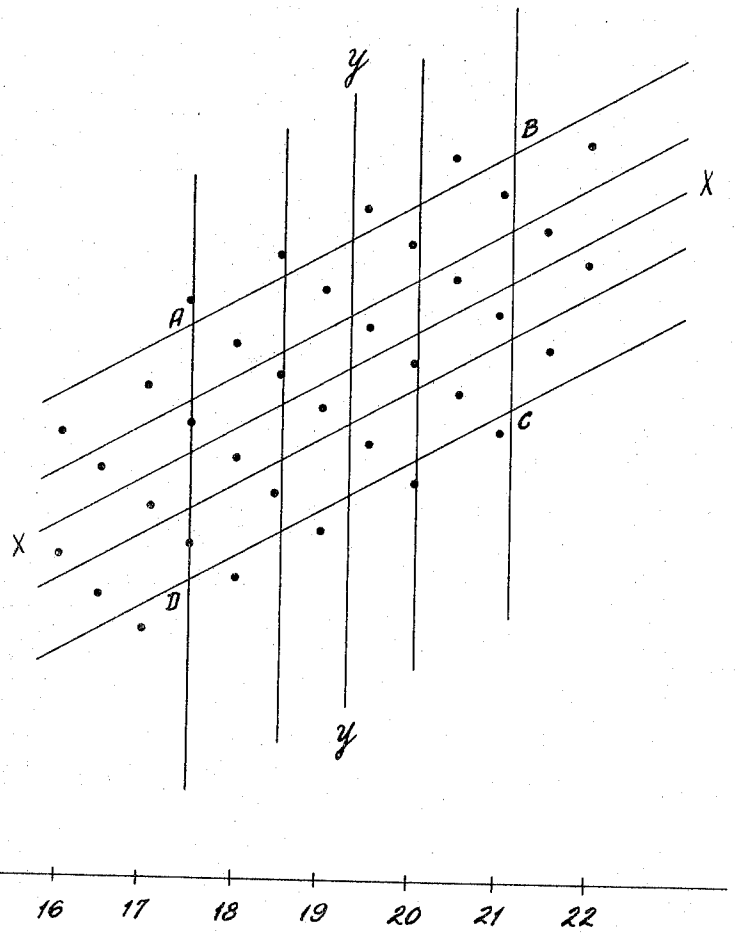

FIG. 4

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3,321,833

MANUFACTURE OF SHOES

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5 Claims. (Cl. 33—6)

This invention relates to the manufacture of shoes, lasts, and patterns and parts for shoes, and particularly concerns the grading of such, between "sizes," so as to achieve the best fit of the most feet with the minimum number of shoes in a tariff.

In the parlance of the shoe industry, and as used herein, the term "tariff" means a group or series of pairs of shoes, shoe-patterns, shoe-parts, or lasts, which are all alike except for variations in dimensions and sometimes except for color or type of leather. Thus, a given "tariff" does not necessarily include all possible variations in "size," etc., but only those which a manufacturer or a merchant may deem necessary to satisfy the demands of his trade.

As is well known, shoes conventionally are designated by "size" and by "width." Neither "size" nor "width" is indicative of a standard finite dimension. "Size" is indicative of overall length ("stick length") and is measured from heel to toe on a foot or last. "Width" is indicative of "ball girth," which is the least measurable girth at the break on the outside of the foot or last. Each expresses only a relationship to the corresponding dimensions of a "model."

Conventionally, the finite dimensions of shoes, lasts, patterns, or shoe parts, in a given tariff, vary (as the "size" or "width" changes) by increments added to or subtracted from the corresponding dimensions of a "model." The "model" may be of any selected length and ball girth, as it merely provides the base from which the dimensions of other members in a tariff of shoes, lasts, or the like, are developed.

The dimensional increments by which successive "sizes" or "widths" differ has become more or less standardized in the shoe manufacturing industry, although the finite dimensions have not, and that degree of standardization is hereinafter referred to as "conventional." In the conventional practice, men's shoes are so varied that each progression in "size" involves the addition of an increment to the length of the "model" where the "size" is greater than the "size" of the "model"; or the subtraction of an increment from the length of the "model" where the "size" is less than that of the "model." There are in vogue two systems for accomplishing this variation. The most widely used system is called the arithmetic system, while the system used by the military is known as the geometric system.

According to the conventional arithmetic system, the "sizes" are indicated by numerals, i.e., whole numbers, with intervening half numbers. While in some quarters, the half numbers are considered to represent "half-sizes," for the purpose of this disclosure, the term "size" embraces not only those conventionally designated by whole numbers, but those designated by half numbers, so that "6½" will be regarded as much a "size" as will "6." In the conventional arithmetic system, if the "model" be indicated as "size" "7," then: "size" "7½" is one sixth of an inch longer than the "model"; "size" "8," one third of an inch longer than the "model"; etc., while "size" "6½" is a sixth of an inch shorter than the "model," etc. As the length of shoes increases or decreases above or below that of the "model," it is customary to vary the ball girth by one eighth of an inch per "size," that is to say, that if the "model" be designated "size" "7," "width" "B": "size" "7½," "width" "B," will have a ball girth one eighth of an inch greater than the "model"; and "size" "6½," "width" "B," will have a ball girth one eighth of an inch less than the "model." Likewise, as "widths" increase or decrease in a given "size," it is customary to increase or decrease the ball girth by one quarter of an inch. For example, if the "model" be "size" "7," "width" "B": "size" "7," "width" "C," will be expected to have the same length as the "model," but its ball girth will be a quarter of an inch greater than that of the "model"; while "size" "7," "width" "A," will have a ball girth a quarter of an inch less than the "model." Thus, in the conventional arithmetic system for a given tariff, as the "size" of the shoe increases without changing "width," the ball girth nevertheless increases one-eighth inch for each one-sixth inch increase in length. This is in the ratio of three units' increase in ball girth to each four units' increase in length, and such ratio, when expressed in percentage, is hereinafter termed the "gradient," to wit: for the conventional arithmetic system, the gradient is 75%.

According to the conventional geometric system, both the length and ball girth vary in the same proportion as the length of the shoe varies above or below that of the "model" without changing "width." In practice, 3% was chosen as the arbitrary proportion in which to vary both length and ball girth between "sizes" without change of "width." This yields a gradient higher than 75%. For example, with a "model" having a length of 11.28 inches and a ball girth of 9.32 inches: 3% of these values is, respectively, 0.3384 inch and 0.2796 inch, which is a gradient of 82.5%. To simplify the use of the geometric system, a scale has been provided which is graduated in "points," no two of which are of the same length because each is 103% of the length of the next smaller. For example, the hundred "points" between 900 and 1000 "points" is approximately $2\frac{9}{64}$ inches, while the hundred "points" between 1100 and 1200 "points" is approximately $3\frac{23}{32}$ inches.

For shoes of various "sizes" developed from a given "model," the differential in the overall length (commonly termed "stick length"), as between "sizes," is supposed to be, and usually is, uniform, either ⅙ of an inch (in the arithmetic system) or 3% (in the geometric system). However, this does not mean that shoes of the same stated "size," but developed from different "models", will necessarily have the same "stick length." Toe styling is largely responsible for non-uniformity in "stick length" as between shoes developed from different "models." The Army has carried out an extensive program of measuring male feet, and the results thereof are published in a report entitled, "Application of Foot Measurements to the Development of Last Systems." As a result of having measured some 6,500 pairs of adult male feet, it was determined that, insofar as concerns the fitting of shoes to feet, the two most important measurements are overall length and ball girth; and that the measured male feet widened with increasing length at a lesser rate than do lasts graded on the conventional systems.

It is the object of the present invention, generally stated, to provide a tariff of lasts, patterns and shoe parts from which the resultant shoes will better fit the feet of most people, and, at the same time, reduce the number of shoes in a given tariff.

Accordingly, the invention involves the grading of lasts, patterns, shoes, and shoe parts, so that, as between successive "sizes" of the same "width," the ball girth and the stick length vary in the ratio of about 54 (±10%) increments of girth to each hundred increments of length, such increments each being additive as the "size" increases above that of the "model," and subtractive as the "size" decreases below that of the "model."

The invention further contemplates increasing the finite differential (between successive "sizes") in length over that which has been conventional. This aspect of the invention is predicated upon the discovery, based in part upon analysis of the Army measurements, that when the lasts are graded as aforesaid, a higher incidence of satisfactory fit and a substantial reduction in the number of members in a tariff will be achieved if the differential in length between successive "sizes" of shoes (from the same "model") be increased from one-sixth inch to one-quarter inch. Thus, in the arithmetic system, the ball girth increment of increase or decrease as between successive "sizes" of the same "width," can remain at the conventional one-eighth inch as previously practiced in the conventional arithmetic system, but nonetheless result in a gradient of 50%.

On the other hand, where it is desirable to retain the conventional (one-sixth inch) increment of length as between "sizes" at the same "width," the differential in ball girth (as between successive "sizes" in the same "width") can be reduced to three thirty-seconds of an inch to produce a gradient of 56.3%.

While it is such a radical departure from custom that it introduces a complex problem of re-educating personnel, and hence may appear impractical, improved fitting with fewer shoes in the tariff can be achieved by staggering "sizes" in "widths" and "widths" in "sizes." This can be accomplished simply by eliminating the so-called "half-sizes" in alternate "widths," and eliminating the so-called "full sizes" in the intervening "widths" in an arithmetic system in which the gradient is maintained at about 54 (±10%) units of increase or decrease in ball girth dimension to each one hundred units of increase or decrease in length.

In applying the principles of the invention to the geometric system of grading, where measurements are taken in "points" and the finite length of each "point" is different from every other, I have discovered a simple way to maintain the gradient within the range aforesaid. In the normal range of men's shoe "sizes," the stick length varies from about 1086 to about 1170 points. In spite of the fact that the finite length of a point near 1170 is about 125% of the finite length of a point near 1086, a gradient of between 50% and 59% can be maintained by adding or subtracting seven "points" in length, and five "points" in ball girth between successive "sizes"; and this remains true for the various widths when 9 points are added or subtracted between "widths" of the same "sizes."

To clarify the foregoing, as well as that which follows, reference may be made to the accompanying drawings, in which:

FIGURE 1 is a view in side elevation of a typical last for men's shoes, and shows the locations at which the "stick length" and "ball girth" are measured;

FIGURE 2 is a correlative scale showing the relationship between "points" (in the geometrical system) and inches, within the parameters pertinent to the present disclosure;

FIGURE 3 is a graph showing the relationship between ball girth and length in two tariffs of men's lasts graded, respectively, by the arithmetic and geometric systems in accordance with the present invention, and correlating them with the Army foot measurements hereinbefore mentioned; and

FIGURE 4 is a graph comparable to FIGURE 3, but showing the relationship between ball girth and length among a tariff of lasts graded in accordance with the present invention, and which involves the staggering of "sizes" in "widths," and "widths" in "sizes."

From an analysis of the individual measurements taken by the Army on 6500 adult male feet, I have ascertained that the quadrangle ABCD in FIGURE 3 delineates the

dimensions of sixty-four percent of the feet measured. Within said quadrangle, there are sixteen lesser quadrangles, each labeled 4, and each of which embraces four percent of the feet measured. Outside the quadrangle ABCD, the open-ended areas labeled 2 each embrace two percent of the feet measured; and the corner areas labeled 1 each embrace one percent of the feet measured. The ball girth (plotted vertically) and length (plotted horizontally) of the average male foot is indicated by the intersection O of lines X—X and Y—Y.

In FIGURE 3, the intersections of the cross-bars of the thirty-five plus marks (+) represent the loci of the ball girth and length for a tariff of lasts graded by the geometric system, and which will serve more than ninety percent of adult male feet; and the thirty-five dots (·) represent the loci of the ball girth and length for another tariff of lasts graded by the arithmetic system, and which will likewise serve more than ninety percent of adult male feet. In each tariff, the gradient is approximately fifty-four units of ball girth to each hundred units of length. In other words, the two tariffs delineated, each of thirty-five members, provide as good fitting qualities for as many feet as sixty or more members in a tariff as conventionally organized.

The geometric tariff indicated by the plus marks in FIGURE 3 utilizes increments: between successive "sizes," of seven "points" in length and five "points" in ball girth; and between successive widths in the same "sizes," of nine points in ball girth, and zero points in length. The increments are additive as the size and/or width increases above the model; and are subtractive as the size and/or width decreases below the model. In the geometric system, it will be remembered that no two "points" are of exactly the same magnitude, and hence the finite length of seven points is slightly greater in the larger sizes and less in the smaller sizes than in the medium ones, but within the parameters of dimension concerned with a given style of shoe, such differences are not sufficiently significant to warrant compensation or adjustment, especially when the model is chosen about the middle of the tariff, for example, that closest to the intersection of lines X—X and Y—Y in FIGURE 3. For example, among the men's sizes and widths plotted with plus marks on FIGURE 3, the model has a length of 1128 points and a ball girth of 1053 points; and the point values for the other members of the tariff are as shown in Table I:

TABLE I

Stick length	1107	1114	1121	1128	1135	1142	1149	1156
Ball Girth	1029	1025 1034	1030 1039	1035 1044	1040 1049	1045 1054	1059	1064
	1038	1043	1048	1053	1058	1063	1068	1073
	1047	1052	1057	1062	1067	1072	1077	1082
	1056	1061	1066	1071	1076	1081		

The part of the tariff at which there is the greatest variety of nominal "widths" per nominal "size" is, in the parlance of the trade, termed the "heart" of the tariff, and is illustrated in the foregoing Table by the twenty-five different ball girths within the stick length range of 1114 through 1142 points, which is less than one inch.

The arithmetic tariff indicated by the dots in FIGURE 3 utilizes increments: between successive "sizes" in the same "width," of one-quarter inch in length and one-eighth inch in ball girth; and between successive widths in the same "size," of one-quarter inch in ball girth and none in length. As before, the increments are additive above the model, and subtractive below the model. Again, the

model is preferably taken in the middle of the tariff, for instance, that nearest to the intersection O of lines X—X and Y—Y, whose dimensions are, for example, 11.54 inches in length and 9.19 inches in ball girth. The dimensions (in inches) of the other members of the illustrative tariff are as shown in Table II:

TABLE II

Stick Length	10.79	11.04	11.29	11.54	11.79	12.04	12.29	12.54
Ball Girth	8.5625	8.4375	8.5625	8.6875	8.8125	8.9375		
	8.8125	8.6875	8.8125	8.9375	9.0625	9.1875	9.3125	
	9.0625	8.9375	9.0625	9.1875	9.3125	9.4375	9.5625	9.6875
	9.3125	9.1875	9.3125	9.4375	9.5625	9.6875	9.8125	9.9375
		9.4375	9.5625	9.6875	9.8125	9.9375	10.0625	

In the tariff illustrated in Table II, the "heart" embraces stick lengths ranging from 11.04 inches through 12.04 inches, and there are thirteen different ball girths within that one inch range of stick length variation.

By comparison of Tables I and II, it will be found that the arithmetic tariff provides, in the greatest width, one more larger size than does the geometric tariff; and that the geometric tariff provides, in the second narrowest width, one more larger size than does the arithmetic system. The reason for this is the same in both situations, to wit: the elimination of members for which there will be little or no need. In the former instance, to have provided the additional member would have thrown it into the area on the graph where it would serve but a fraction of one percent of the potential customers. In the latter instance, to have provided the additional member would have thrown it at the outer margin of an area on the graph which serves only two percent of the potential customers, and which is occupied, as it is, by one member.

It should be made abundantly clear that the finite dimensions for overall length, hereinbefore stated and plotted in FIGURE 3, are by no means inflexible. In fact, they are, to an extent, arbitrary with the stylist who depends to a considerable extent upon manipulating the toe of a shoe to accomplish his desideratum of appearance. Once a model is produced, however, the gradients and increments herein disclosed can be applied thereto to develop the critical dimensions of the other members of the tariff. As stated hereinbefore, the model last (and hence the inside of a shoe made thereon) is preferably of a size and width near the middle of the tariff, with the dimensions adjusted by a reasonable "fitting allowance" for the average foot which is to say that the ball girth of the last is less, but the stick length of the last is greater (by the fitting allowance), than the same dimensions of the corresponding foot.

While any grading increments that result in good fittability to all feet within the dimensions sought to be fitted may be used, in accordance with the present invention, the ball girth grade is, as aforesaid, in the neighborhood of 0.54 times the length grade between sizes. However, the ball girth and length grading increments illustrated in Tables I and II for men's shoes provide good fittability with the practical minimum number of members in a tariff which includes the full range of widths in all sizes.

A further embodiment of the invention is plotted in FIGURE 4. This embodiment introduces the concept of staggering "widths" in "sizes" and "sizes" in "widths," in addition to the gradient concept hereinbefore described.

In FIGURE 4, the length increment between successive "sizes" of a same nominal "width" is ⅓ of an inch, while the ball girth increment is $\frac{3}{16}$ of an inch; and the ball girth increment between successive nominal "widths" in the same "sizes" is $\frac{7}{16}$ of an inch—i.e., substantially greater than in the FIGURE 3 embodiment. There are but three "widths" in any given "size," and alternate "sizes" have different nominal "widths." As in FIGURE 3, the several series of points aligned vertically represent different "widths" in the same "size"; and the several series of points aligned more or less parallel with line X—X represent different sizes of the same nominal "width." To finitely illustrate the FIGURE 4 embodiment, the model may be chosen to have a ball girth of 9.12 inches and a length of 11.48 inches. Corresponding dimensions (in inches) for other members of the tariff are shown in the following Table III.

TABLE III

Stick Length	10.48	10.64	10.81	10.98	11.14	11.31	11.48	11.64	11.81	11.98	12.14	12.31	12.48
Ball Girth	8.5625	8.4375	8.3125	8.625	8.5	8.8125	8.6875	9	8.875	9.1875	9.0625	9.375	
	9	8.875	8.75	9.0625	8.9375	9.25	9.125	9.5375	9.3125	9.625	9.5	9.8125	9.6875
			9.1875	9.5	9.375	9.6875	9.5625	9.875	9.75	10.0625	9.9375		10.125

In the tariff illustrated in Table III, the "heart" embraces stick lengths ranging from 10.81 inches through 12.14 inches, and includes twenty-four different ball girths (some of which appear more than once), but in any given inch of stick length range, as between 10.81–11.81, 10.98–11.98, or 11.14–12.14, there are respectively twenty, twenty-one and twenty different ball girths.

It is apparent from FIGURE 4 that, in that embodiment, there are only sixteen members within, or bordering on, the 64% area on the graph, whereas, in FIGURE 3, there are twenty, and that twenty-six members of the tariff of FIGURE 4 accommodate almost as many feet as do all thirty-five member tariffs of FIGURE 3. Thus, if a thirty-five member tariff be regarded as the desideratum, the staggering concept of FIGURE 4 provides for additional members wherever they are most needed (in any particular style) beyond the bourn of the 64% area on the graph. These fringe members are shown in FIGURE 4 as the two two-member smallest "sizes" (at the left), the one four-member greatest "width" (at the top), and the one in the outside corner at D.

It is also apparent from FIGURE 4 that, comparable with FIGURE 3, the gradient (between successive "sizes" in the same "width") is 56.2%, but, unlike FIGURE 3, the reverse gradient between any given member and its next larger and wider, or its next smaller and narrower, neighbor is also about 54 (±10%) percent, which latter condition does not obtain with the tariffs of FIGURE 3.

From the foregoing disclosure, those skilled in the art should readily understand that the invention accomplishes its objects, and provides a method of grading shoes, lasts, patterns, and shoe parts, whereby improved fittability is achieved with tariffs having a substantially reduced number of members than those heretofore provided.

While, in the foregoing disclosure, reference has been made to finite dimensions, it is to be understood that such finite dimensions are given only for the purpose of il-

lustrating the invention, and may be varied to meet the exigencies of the occasion without departing from the spirit of the invention, provided the gradient of between 48.6% and 59.4% is maintained. Otherwise, it is contemplated that variations in the finite dimensions will occur in the normal course of shoe designing without departing from the spirit of the invention or the scope of the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. The method of grading lasts for the manufacture of shoes, which comprises, providing a model, grading from that model

(a) a plurality of groups of different nominal widths, the individual groups each consisting of a plurality of members all of the same nominal width, but differing from each other in length and in ball girth by increments of about 0.54 (±10%) units of ball girth to each whole unit of length,

and grading from that model

(b) a plurality of groups of different lengths, the individual groups each consisting of a plurality of members all of the same length but differing from each other in nominal width and in ball girth,

selecting the lengths and widths in the respective groups to provide a heart in which each member of an (a) group is in a (b) group and each member of a (b) group is in an (a) group; and coordinating the length increments by which the respective (b) groups differ from each other, with the ball girth increments by which the members of the (a) group differ from each other to obtain at least thirteen different ball girths within (a) groups whose lengths differ by no more than one inch.

2. The method of claim 1 in which the grading is on the geometric system, and the gradient for the (a) groups is by increments of about five points in ball girth to each seven points in length.

3. The method of claim 1 in which the grading is on the geometric system and the ball girth of a member of a (b) group differs from that of its nearest neighbor in that (b) group by about nine points.

4. The method of claim 1 in which the grading is on the arithmetic system and the gradient for the (a) groups is by increments of about ⅛ inch in ball girth to each ¼ inch in length.

5. The method of claim 1 in which the grading is on the arithmetic system and the ball girth of a member of a (b) group differs from that of its nearest neighbor in that (b) group by about ¼ inch.

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